Using ASTER to Validate the MODIS/Terra *Fire and Thermal Anomalies* Product

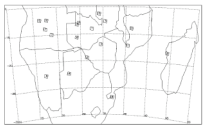
Wilfrid Schroeder[1], Louis Giglio[2], Ivan Csiszar[3], Christopher Justice[2], Jeffrey Morisette[4]

[1]ESSIC/Univ. of Maryland (email:.wilfrid.schroeder@noaa.gov), [2]Geography/Univ. of Maryland,[3]NOAA/NESDIS/STAR,[4]USGS/Fort Collins

Introduction

Thanks to its fine spatial resolution and overall data quality, ASTER provides a unique opportunity to look at sub-pixel fire activity coincidently detected by the MODIS instrument onboard the EOS Terra spacecraft. Here we present a synthesis of the use of ASTER data to validate the MODIS/Terra *Fire and Thermal Anomalies* product. We start with a short description of previous validation studies, and describe the current MODIS/Terra global fire validation including omission and commission errors estimates and examples of peculiar conditions affecting product performance.

Build Up of Validation Procedure



- Sample Size: 18 ASTER scenes
- Region: Southern Africa

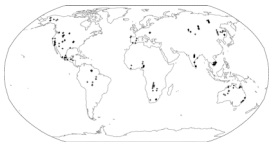
➢ Proof of concept using fixed threshold method applied to ASTER band 9 to derive higher resolution active fire masks

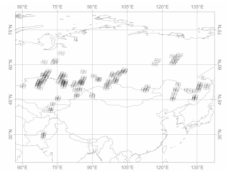
☞Morisette et al. 2005

- Sample Size: 100 ASTER scenes
- Region: Global

➢ Development of contextual active fire detection algorithm for ASTER using bands 3N, 8

☞Giglio *et al.* 2008





- Sample Size: 131 ASTER scenes
- Region: Northern Eurasia

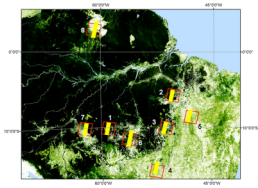
➢ Development of active fire validation protocol

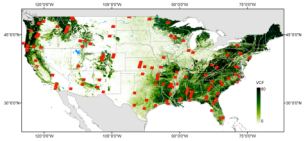
☞Csiszar *et al.* 2006

- Sample Size: 24 ASTER + 8 Landsat ETM+ scenes
- Region : Brazilian Amazonia

➢ Analyses of short-term variations in fire behavior and implications for satellite active fire validation

☞ Csiszar and Schroeder 2008

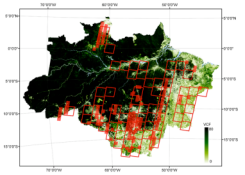




- Sample Size: 115 ASTER scenes
- Region: CONUS

➢ Validation of NOAA/NESDIS operational fire monitoring system including analyst data

☞Schroeder *et al.* 2008b



- Sample Size: 167 ASTER + 123 Landsat ETM+ scenes
- Region : Brazilian Amazonia

➢ Generalization of moderate-coarse resolution fire data validation (MODIS & GOES) using higher resolution imagery (ASTER & ETM+)

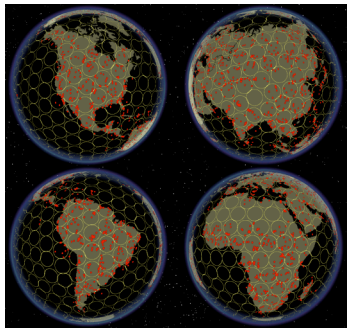
☞ Schroeder *et al.* 2008a

Global Fire Validation

- Use of equidistant grid (circular - 900km diameter)
  - 642 cells
  - ~370 over land
  - ~210 in areas with some fire activity (deserts and poles automatically excluded in the process)
- Six years of data represented
  - 2001-2002; 2003-2004; 2005-2006
  - ASTER SWIR data quality issues beginning May 2007
- ~2500 ASTER scenes selected
  - 4 scenes for each grid cell - 2 year period
  - up to 3 scenes representing highest number of MOD14 fire pixels
  - at least one random scene per cell/period containing fire, no fire, water, clouds, etc.
  - 140 nighttime scenes

⇒ 16K daytime MOD14 fire pixels sampled

⇒ 700 nighttime MOD14 fire pixels sampled



Results

The results are primarily based on the summary statistics of ASTER 30m active fire pixels found within the MODIS Terra footprint. Active fire area estimates can be derived by multiplying the number of ASTER fire pixels by their total area (i.e., 900m^2). This approximation should be used as an upper limit value as individual ASTER fire pixels may only be partially occupied by fires.

Temporal Consistency

The temporal analysis of the MOD14 product showed no statistically significant variation in performance over time. Figure 1 represents a subset of the global data corresponding to fire pixels located in areas with intermediate tree cover. This subgroup had the largest population leading to greater robustness of analysis.

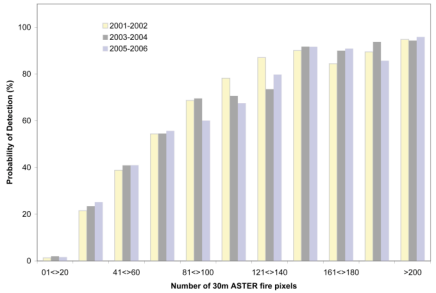


Figure 1: Probability of detection using multi-year MOD14 data.

Dependency on Vegetation Cover

Probability of detection for the MOD14 product was found to vary with tree cover percentage (TC) (MODIS Vegetation Continuous Fields product; Hansen *et al.*, 2003). On average, there was a 10% difference in detection probability for small-to-intermediate fires (1-100 ASTER fire pixels) detected in low and high TC regions (Figure 2).

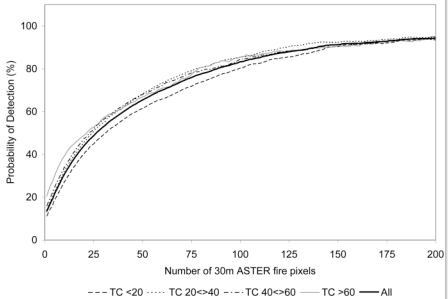


Figure 2: Probability of detection for the MOD14 product using four different tree cover percentage (TC) intervals.

Results *(cont'd)*

Commission Errors

False alarm rates were estimated based on the prevailing tree cover percentage (Figure 3). Recently burned pixels with discernable scars constituted a large fraction of the false alarms. Fire-unrelated commission errors were on average only 2%. Nighttime commission error rate was zero.

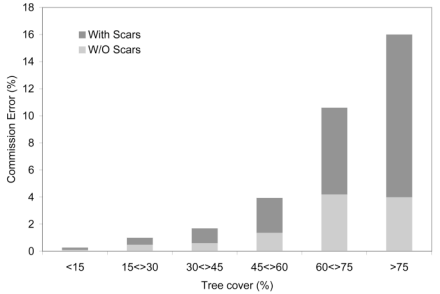
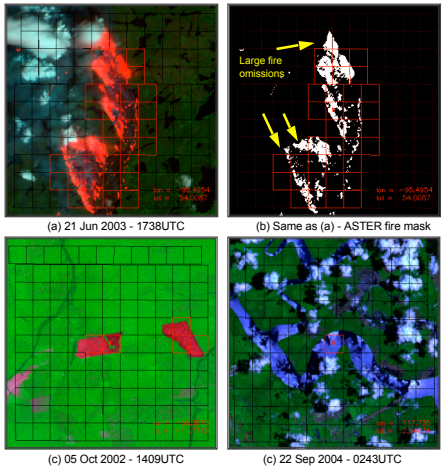


Figure 3: Commission error estimates (%) calculated for MOD14.

Future development

Further algorithm improvement is being performed using cases representing omission and commission errors that were not resolved by the current MOD14 (Collection 5) product.



(a) 21 Jun 2003 - 1738UTC

(b) Same as (a) - ASTER fire mask

(c) 05 Oct 2002 - 1409UTC

(c) 22 Sep 2004 - 0243UTC

Figure 4: Depiction of conditions that lead to errors in the MOD14 product. (a-b) omission of large fire involved in heavy smoke; (c) false alarms induced by large surface radiance constrast (deforestation); (d) sun glint over river. MODIS 1×1km nominal pixel grid is shown in black with MOD14 fire pixels highlighted in red; background correspond to ASTER RGB (bands 8-3-1); center coordinate is marked in the image.

Remarks

Sharing the EOS Terra spacecraft with MODIS, ASTER instrument data have allowed in-depth analyses of the omission and commission errors associated with NASA's *Fire and Thermal Anomalies* (MOD14) global product. The good overall ASTER data quality guarantees quick and accurate matching of coincident MODIS images, facilitating sub-pixel retrieval of fire summary statistics used in the quantification of the MOD14 product performance.

References

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